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Request for grant of a patent

16JUL02 E733221-5 D02846
P01/7700 0.00-0216302.0

1.	Your Reference	PLB/CC/W531
2.	Application number	13 JUL 2002 0216302.0
3.	Full name, address and postcode of the or each Applicant Country/state of incorporation (if applicable)	**Per-Tec Limited** **Manchester School of Engineering** **The University of Manchester** **Simon Building** **Oxford Road** **Manchester M13 9PL** **Incorporated in: England & Wales**
	08093106001	
4.	Title of the invention	**Improvements In and Relating to Gas Flow Arrangement Apparatus**
5.	Name of agent	**APPLEYARD LEES**
	Address for service in the UK to which all correspondence should be sent	**15 CLARE ROAD** **HALIFAX** **HX1 2HY**
	Patents ADP number	**190001**

6. Priority claimed to:

Country	Application number	Date of filing

7. Divisional status claimed from:

Number of parent application	Date of filing
-	-

8. Is a statement of inventorship and of right to grant a patent required in support of this application? **YES**

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	15 x 2
Claim(s)	7 x 2
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Drawing(s)	11 x 2

10. If you are also filing any of the following, state how many against each item

Priority documents	
Translation of priority documents	
Statement of inventorship and right to grant a patent (PF 7/77)	
Request for a preliminary examination and search (PF 9/77)	1
Request for substantive examination (PF 10/77)	1
Any other documents (please specify)	

11. We request the grant of a patent on the basis of this application.

Signature: **APPLEYARD LEES** Date: **12 July 2002**

Appleyard Lees

12. Contact **Paul Brandon – 0161 835 9655**

IMPROVEMENTS IN AND RELATING TO GAS FLOW ARRANGEMENT APPARATUS

Field of the Invention

The present invention relates to gas flow arrangement apparatus and to pollutant removal devices incorporating such gas flow arrangements.

Background to the Invention

The present invention finds particular, but not exclusive, application in the field of the removal of pollutants from vehicle exhaust gas streams. In this technological application, often a filter is used to remove pollutants, especially particulate pollutants. However, as particulate material is built up in the filter, the porosity of the filter decreases thus increasing back pressure on the exhaust system which can reduce engine efficiency. Since environmental concerns are the primary reason for removing pollutants, such a decrease in efficiency, with a resultant increase in pollutants, defeats the object of many such proposed filtration devices.

It is an aim of preferred embodiments of the present invention to obviate or overcome at least one disadvantage of the prior art, whether referred to herein or otherwise.

Summary of the Invention

According to the present invention in a first aspect, there is provided a gas flow arrangement apparatus

comprising a gas entrance and a gas exit, a first flow path from the gas entrance to the gas exit through a means for at least partly removing at least one pollutant from a gas flow stream and second flow path from the gas entrance to the gas exit other than through the removing means.

Suitably, gas passing through the pollutant removing means intersects the first gas flow.

Thus pressure differences can be minimised and undue back pressure is avoided. To the extent that gas is blocked from a first it can follow the second flow path avoiding the filter.

Suitably, the first flow path diverges from the second flow path upstream of the pollutant removing means.

Suitably, the first flow path and the second flow path intersect with each other downstream of the pollutant removing means. Thus the gas in one flow path is reintroduced into the gas of the other flow path.

Suitably, the first gas flow splits from the second gas flow path at a separator for diverting pollutant to the pollutant removing means. Suitably, the separator is generally conically shaped with an opening for one of the gas flow paths therethrough.

Suitably, the first flow path diverges from the second flow path at a tube through which gas can pass. Suitably, the tube is a perforated tube.

The first and second flow paths may be in common for some of their respective passages through the arrangement, but they form discrete flow paths before intersecting downstream of the filter.

Suitably, the arrangement comprises a gas flow tube for the second flow path, which gas flow tube comprises a slot for the first gas flow path to join the second gas flow path.

Suitably, the arrangement comprises a first chamber, a second chamber and a third chamber, whereby gas enters into a first chamber, passes into a second chamber at which the first flow path diverges from the second flow path, and whereby gas can flow into the third chamber through two openings one of which comprises the pollutant removing means, and in which there is an exit for gas from the third chamber.

Suitably, the pollutant removing means comprises a filter.

Suitably, the filter comprises a regenerative filter. Suitably, the filter is electrically regenerative.

Thus, the arrangement provides a gas flow apparatus.

According to the present invention in a second aspect, there is provided a pollutant removal device for at least partly removing a pollutant from a gas flow, the device comprising a gas flow arrangement apparatus according to the first aspect of the invention.

Suitably, the device comprises means for at least partially ionising gas flow. Suitably, the ionising means comprises an electrode for electrostatic precipitation. Suitably, the electrode is mounted in the second chamber. Suitably, the electrode is mounted in the first chamber.

Suitably, the apparatus comprises a tube through which the gas stream at least partly flows, whereby the tube is at least partly porous to the gas stream.

Suitably, the tube is at least partly about the ionising means.

Suitably, the tube is perforated. Suitably, the tube comprises a plurality of holes therethrough. Suitably, the holes are evenly spaced. Suitably, the holes are evenly sized. Suitably, the perforated region of the tube is substantially annular. Suitably, the perforated region of the tube extends for a substantial length thereof.

Suitably, the tube comprises at least one slot therethrough. Suitably, a plurality of slots is provided. Suitably, the slots are substantially evenly distributed about the tube. Suitably, the at least one slot runs longitudinally along the tube.

Suitably, a major portion of the tube is porous. Alternatively a minor portion of the tube is porous.

Suitably, the tube is circular in cross-section. Suitably, the tube comprises an inlet and an outlet.

Suitably, the cross-sectional area of the tube decreases along its length from the input to the output thereof.

Suitably, the tube is at least partly coated with a barrier coating for showing the discharge time of charged agglomerates.

Suitably, the electrode is mounted at one end thereof only.

Suitably, the tube is located in the first and second gas flow paths. The tube acts to split the gas flows and concentrate at least one pollutant in one flow path for subsequent removal.

Suitably, the apparatus comprises a first expansion tube in fluid communication with an apparatus gas inlet. Suitably, the diverting tube extends from the first expansion tube to a second expansion tube defined by the tube. Suitably, there is a third expansion tube about the diverting tube into which gas can flow through the diverting tube. Suitably, a filter is located between (in respect of gas flow) the second and third expansion tubes.

Suitably, the device is arranged whereby at least one pollutant is biased towards the first flow path (ie a substantial majority of an input pollutant flows through the first flow path, subject to being trapped by the filter).

Suitably, a catalytic converter is provided in the second flow path.

Suitably, the electrode projects from the first chamber in to the second chamber.

Suitably, the second flow path includes a catalytic converter.

Suitably, the device is for fitting to a vehicle exhaust. Suitably, the device is for fitting within the silencer of a vehicle exhaust.

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

Figure 1 is a schematic perspective (partly cut away) illustration of a gas flow arrangement apparatus according to an embodiment of the present invention.

Figure 2 is a schematic perspective (partly cut away) illustration of the gas flow arrangement shown in Figure 1 from a reverse angle.

Figure 3 is a longitudinal cross-sectional view of the arrangement shown in Figures 1 and 2.

Figure 4 is an enlarged partly cut away and sectional drawing of the filter shown in Figures 1 and 2.

Figure 5 is a schematic partly cut away illustration of an embodiment of a particulate filtration device according to the present invention.

Figures 6 and 7 are schematic partly cut away illustrations of two further embodiments of a device according to the present invention.

Figure 8 is a schematic longitudinal cross-sectional view of an electrode mount.

Figure 9 is a schematic partly-sectional elevation of a gas flow arrangement apparatus according to a yet further embodiment of the present invention.

Figure 10 is a perspective view of a second gas flow path tube and filter of Figure 9.

Figure 11 is a sectional view of a further electrode mounting arrangement.

Description of the Preferred Embodiment

Referring to Figures 1-3 of the drawings that follow, there is shown a gas flow arrangement apparatus within a circular cylindrical tubular body indicated by dashed line 2. The body 2 is defined internally by wall plates 4, 6, 8 and 10 respectively into a first chamber 12, a second chamber 14 and a third chamber 16. The body 2 is provided with a gas entry tube 18 and gas exit tube 20. Gas entry tube 18 extends from the exterior wall plate 4 to first chamber 12. That is, gas enters at the entrance of 18 and exits into first chamber 12. Gas exit tube 20 extends from the exterior of wall plate 10 to third chamber 16. Additionally, there is provided a perforated tube 22 extending between first chamber 12 and third chamber 16,

the perforations opening into second chamber 14. The tube 22 is highly perforated whereby in a given annulus there is more area taken up by holes than by solid. The preferred structure is substantially constant radially and longitudinally.

A filter 24 for removing pollutants from the gas stream is mounted in third chamber 16 about an opening 26 between third chamber 16 and second chamber 14.

The filter 24 is an electrically regenerative filter such as the filter identified as 3M part number SK-1739.

The filter 24 is shown in more detail in Figure 4 of the drawings that follow. The filter 24 comprises a tubular outer body 28 of a NEXTEL 312 filtration mounted on a porous metallic frame 30 which is connected to earth (which may be a floating earth) at one end 32. The other end 34 provides an electrical connection 36 (see also Figures 1 and 2) to a power supply 37 (Figure 5) to achieve heating and regeneration of the filter 24 as is known in the art.

An electrode 38 is mounted on wall plate 10 by a ceramic electrode mount 39 to project into the hollow interior of perforated tube 22 as shown in cross-section in relation to Figure 4 of the drawings that follow in which corresponding reference numerals are used.

In use, pollutant eg particulate carrying gas enters the arrangement at 18 and passes into first chamber 12 from which its only route is into perforated tube 22. In operation the electrode is highly charged to between 30kV-

40kV negative polarity d.c. to ionise particulates in the gas stream forcing them through the perforated holes of the tube 22 in to second chamber 14 (under full load the potential may be about 10kV). Additionally, it is believed that the gas becomes at least partly ionised.

The perforated tube 22 opens into third chamber 16 allowing gas to pass through exit tube 20 to exhaust. Further, gas can flow from second chamber 14 to third chamber 14 through hole 26 through filter 24. Thus filter 24 can collect particulate material. The filter 24 is regenerative so that at intervals it is electrically regenerated. This need not be on a regular basis. However, if for any reason the filter 24 does not regenerate fully or a heavy loading occurs causing back pressure between filter 24 and second chamber 14, this is compensated for because gas can still flow to exit tube 20 through perforated tube 22 and third chamber 16. Thus build up of particulates (or other pollutants) in filter 24 will not cause undue back pressure on the engine providing an exhaust stream to the gas flow arrangement. As a result, the problem of back pressure encountered in relation to prior art filtration arrangements is overcome by embodiments of the present invention and there is provided a geometrically efficient and compact gas flow arrangement.

Thus embodiments of the present invention provide a first gas flow path 40 (Figure 5) from gas entrance 18 to gas exit 20 via first chamber 12, tube 22, third chamber 16 through filter 24 and second chamber 14 and a second gas flow path 42 (Figure 4) from gas entrance 18 to gas exit

20 via first chamber 12, tube 22 and second chamber 14 which is other than through the filter 24.

Referring to Figure 6 of the drawings that follow, there is shown another embodiment of a gas flow arrangement and pollutant removal device according to the present invention. The arrangement and device is similar to that described in relation to Figure 5 (and similar reference numerals are used for corresponding integers), except that the first gas flow path 40 through filter 24 is generally straight on, ie the flow path does not diverge substantially from the path of the tube 22 to the filter 24 and the second gas flow path 42 follows the more tortuous route as shown.

To bias the particulate pollutants to follow first gas flow path 40 at Figure 6, instead of a highly perforated tube 22 (considered over the length at tube 22) a small area 50 of perforated tube 52 with a lower hole density is provided. The less perforated tube 52 is not annular, it just occupies a slot in the tube. As the effect of the corona discharge electrode 38 with the floating earth of the tube 52 is to draw particulates to the side (tube 52) walls where they tend to agglomerate, by providing less open area for the agglomerated particulate to pass through, it is less likely that particulates will follow the second flow path 42.

Another difference in the Figure 6 embodiment is the provision of a catalytic converter 54 in the second flow path 42 for the removal of hydrocarbons from the gas stream.

Figure 7 is a yet further embodiment of the present invention substantially similar to the embodiment of Figure 6, except that four equally spaced longitudinal slits 60 are provided over a substantial minority of the surface area of tube 62.

Referring to Figure 8 of the drawings that follow, the electrode mount 39 is shown in more detail. The electrode mount 39 is a one piece ceramic construction having a longitudinal hole 64 therethrough for the electrode 38 (not shown in Figure 8). The electrode projects from distal end 66 and is connected to a power source at end 68. The electrode mount 39 is held by a bracket (not shown) about shoulder 70. Protrusions 72a, 72b and 72c project from the exterior of electrode mount 39. The protrusions 72 are partly hollow, rebated conical shapes that provide a tortuous route from the electrode 38 projecting from distal end 66 to earth to reduce leakage.

Referring to Figures 9 and 10 of the drawings that follow, there is shown a gas flow arrangement apparatus 80 for use in a pollutant removal device in which outer walls are not shown for clarity. The apparatus 80 comprises an ionising electrode 82 in an electrode mount 83, partly surrounded by an electrode hood 84. Electrode 82 extends into an electrode tube 86 which terminates in an outwardly diverging end 88. Spaced from electrode tube 86 is a second gas flow path tube 90 having a generally conically shaped entrance 92 with a central opening 94. The opening 94 is substantially inside the diameter of the walls of electrode tube 84. Tube 90 terminates in an exit 98. About tube 90 is a catalytic filter 100 for at least

partly removing pollutants from a gas stream passing therethrough.

Operation of the embodiment of Figures 9 and 10 is similar to that of the embodiment described above. Exhaust gases, carrying pollutants, enter the apparatus 90 upstream of electrode 82, and pass over hood 84 which serves to help prevent pollutant build up on electrode 82. The electrode 82 is charged to ionise pollutants in the gas flow, which pollutants are therefore attracted to the walls of electrode tube 86 as they flow downstream, leaving relatively cleaner gas towards the centre of the flowstream. The conical opening of second gas flow path tube 90 serves to help deflect pollutant into a first gas flow path (indicated schematically by arrows labelled 102, while the second gas flow path is indicated by arrows labelled 104). The first gas flow path 102 passes through filter 100, which removes some pollutants, and rejoins second gas flow path 104 through a slot 96 in tube 172 downstream to the filter 100. The slot 96 is relatively small compared to the surface area of tube 90. The pressure difference either side of slot 96 is believed to encourage now relatively cleaner gas from the first gas flow path downstream of filter 100 to rejoin the second gas flow path. Second gas flow path 104 passes through second gas flow path tube 90 carrying relatively cleaner gas. The rejoined gas streams, pass out of the apparatus at exit 98.

In any of the embodiments resistive organic barrier coating may be provided over the inner surface of the tube (22 in Figure 1) downstream of the beginning of the electrode. The barrier coating is preferably over

substantially all of the inner surface of the tube. The coating is TLHB/02 available from Camcoat Performance Coatings on 127 Hoyle Street, Bewsey Industrial Estate, Warrington, WA5 5LR, United Kingdom. It is believed that by reducing the discharge rate of the agglomerated particulates along the tube by providing the coating, the particulates are more likely to stay in the vicinity of the tube.

Referring to Figure 11 of the drawings that follow, an alternative electrode mounting arrangement is shown. Both the electrode mount 83 and electrode hood 84 are formed from a ceramic material.

It is noted that although the maximum exterior diameter of each generally conically shaped protrusion 83 decreases in a downstream direction, the minimum internal diameter are substantially the same ±10%. This is believed to provide additional burn-off pointers if required.

Although the first and second gas flow streams are shown separately in the same tube or area of the apparatus, this is for explanatory purposes only and it will be appreciated that in these regions the gas flows are intermingled.

It is noted that there may be a plurality of devices, a plurality of filters and/or a plurality of catalytic converters.

Instead of using direct current as described above, high frequency a.c can be used.

The reduced gas flow through the filter when compared with a corresponding device in which all of the input gas stream flows through the filter makes the electrical regeneration of the filter more efficient because the thermal effect of the gas flow is correspondingly reduced.

Preferred embodiments of the present invention find particular benefit in the application of pollutant, especially particulate removal from exhaust gas streams, especially of internal combustion engines. For such engines the arrangement can be mounted within the vehicle silencer to avoid taking up unnecessary space. The device may be upstream or downstream of a catalytic converter.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each

feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A gas flow arrangement apparatus comprising a gas entrance and a gas exit, a first flow path from the gas entrance to the gas exit through a means for at least partly removing at least one pollutant from a gas flow stream and second flow path from the gas entrance to the gas exit other than through the removing means.

2. A gas flow arrangement apparatus according to claim 1, in which the gas flow path passing through the pollutant removing means intersects the first gas flow.

3. A gas flow arrangement apparatus according to claim 1 or claim 2, in which the first flow path diverges from the second flow path upstream of the pollutant removing means.

4. A gas flow arrangement apparatus according to any preceding claim, in which the first flow path and the second flow path intersect with each other downstream of the pollutant removing means.

5. A gas flow arrangement apparatus according to any preceding claim, in which the first gas flow splits from the second gas flow path at a separator for diverting pollutant to the pollutant removing means.

6. A gas flow arrangement apparatus according to claim 5, in which the separator is generally conically

shaped with an opening for one of the gas flow paths therethrough.

7. A gas flow arrangement apparatus according to any preceding claim, in which the first flow path diverges from the second flow path at a tube through which gas can pass.

8. A gas flow arrangement apparatus according to claim 7, in which the tube is a perforated tube.

9. A gas flow arrangement apparatus according to any preceding claim, in which the arrangement comprises a gas flow tube for the second flow path, which gas flow tube comprises a slot for the first gas flow path to join the second gas flow path.

10. A gas flow arrangement apparatus according to any preceding claim, in which the arrangement comprises a first chamber, a second chamber and a third chamber, whereby gas enters into a first chamber, passes into a second chamber at which the first flow path diverges from the second flow path, and whereby gas can flow into the third chamber through two openings one of which comprises the pollutant removing means, and in which there is an exit for gas from the third chamber.

11. A gas flow arrangement apparatus according to any preceding claim, in which the pollutant removing means comprises a filter.

12. A gas flow arrangement apparatus according to claim 11, in which the filter comprises a regenerative filter.

13. A gas flow arrangement apparatus according to claim 12, in which the filter is electrically regenerative.

14. A pollutant removal device for at least partly removing a pollutant from a gas flow, the device comprising a gas flow arrangement apparatus according to any one of claims 1 to 13.

15. A pollutant removal device according to claim 14, in which the device comprises means for at least partially ionising gas flow.

16. A pollutant removal device according to claim 15, in which the ionising means comprises an electrode for electrostatic precipitation.

17. A pollutant removal device according to claim 16, in which the electrode is mounted in the second chamber.

18. A pollutant removal device according to claim 17, in which the electrode is mounted in the first chamber.

19. A pollutant removal device according to any one of claims 14 to 18, in which the apparatus comprises a tube through which the gas stream at least partly

flows, whereby the tube is at least partly porous to the gas stream.

20. A pollutant removal device according to claim 19, when dependent on any of claims 15 to 18 in which the tube is at least partly about the ionising means.

21. A pollutant removal device according to claim 19 or claim 20, in which the tube is perforated.

22. A pollutant removal device according to claim 21, in which the tube comprises a plurality of holes therethrough.

23. A pollutant removal device according to claim 22, in which the holes are evenly spaced.

24. A pollutant removal device according to claim 22 or claim 23, in which the holes are evenly sized.

25. A pollutant removal device according to any one of claims 21 to 24, in which the perforated region of the tube is substantially annular.

26. A pollutant removal device according to any one of claims 21 to 26, in which the perforated region of the tube extends for a substantial length thereof.

27. A pollutant removal device according to claim 19 or claim 20, in which the tube comprises at least one slot therethrough.

28. A pollutant removal device according to claim 27, in which a plurality of slots is provided.

29. A pollutant removal device according to claim 28, in which the slots are substantially evenly distributed about the tube.

30. A pollutant removal device according to any one of claims 27 to 29, in which the at least one slot runs longitudinally along the tube.

31. A pollutant removal device according to any one of claims 19 to 30, in which the tube is circular in cross-section.

32. A pollutant removal device according to any one of claims 19 to 31, in which the tube comprises an inlet and an outlet.

33. A pollutant removal device according to claim 32, in which the cross-sectional area of the tube decreases along its length from the input to the output thereof.

34. A pollutant removal device according to any one of claims 20 to 33, in which the tube is at least partly coated with a barrier coating for showing the discharge time of charged agglomerates.

35. A pollutant removal device according to any one of claims 16 to 34, in which the electrode is mounted at one end thereof only.

36. A pollutant removal device according to any one of claims 20 to 34, in which the tube is located in the first and second gas flow paths.

37. A pollutant removal device according to any one of claims 14 to 36, in which the apparatus comprises a first expansion tube in fluid communication with an apparatus gas inlet.

38. A pollutant removal device according to claim 37, in which a diverting tube extends from the first expansion tube to a second expansion tube defined by the tube.

39. A pollutant removal device according to claim 38, in which there is a third expansion tube about the diverting tube into which gas can flow through the diverting tube.

40. A pollutant removal device according to claim 38, in which a filter is located between (in respect of gas flow) the second and third expansion tubes.

41. A pollutant removal device according to any one of claims 14 to 40, in which the device is arranged whereby at least one pollutant is biased towards the first flow path.

42. A pollutant removal device according to any one of claims 14 to 41, in which a catalytic converter is provided in the second flow path.

43. A pollutant removal device according to any one of claims 14 to 42, in which the device is for fitting to a vehicle exhaust.

44. A pollutant removal device according to claim 43, in which the device is for fitting within the silencer of a vehicle exhaust.

45. A gas flow arrangement apparatus substantially as described herein, with reference to the accompanying drawings.

46. A pollutant removal device, substantially as described herein, with reference to the accompanying drawings.

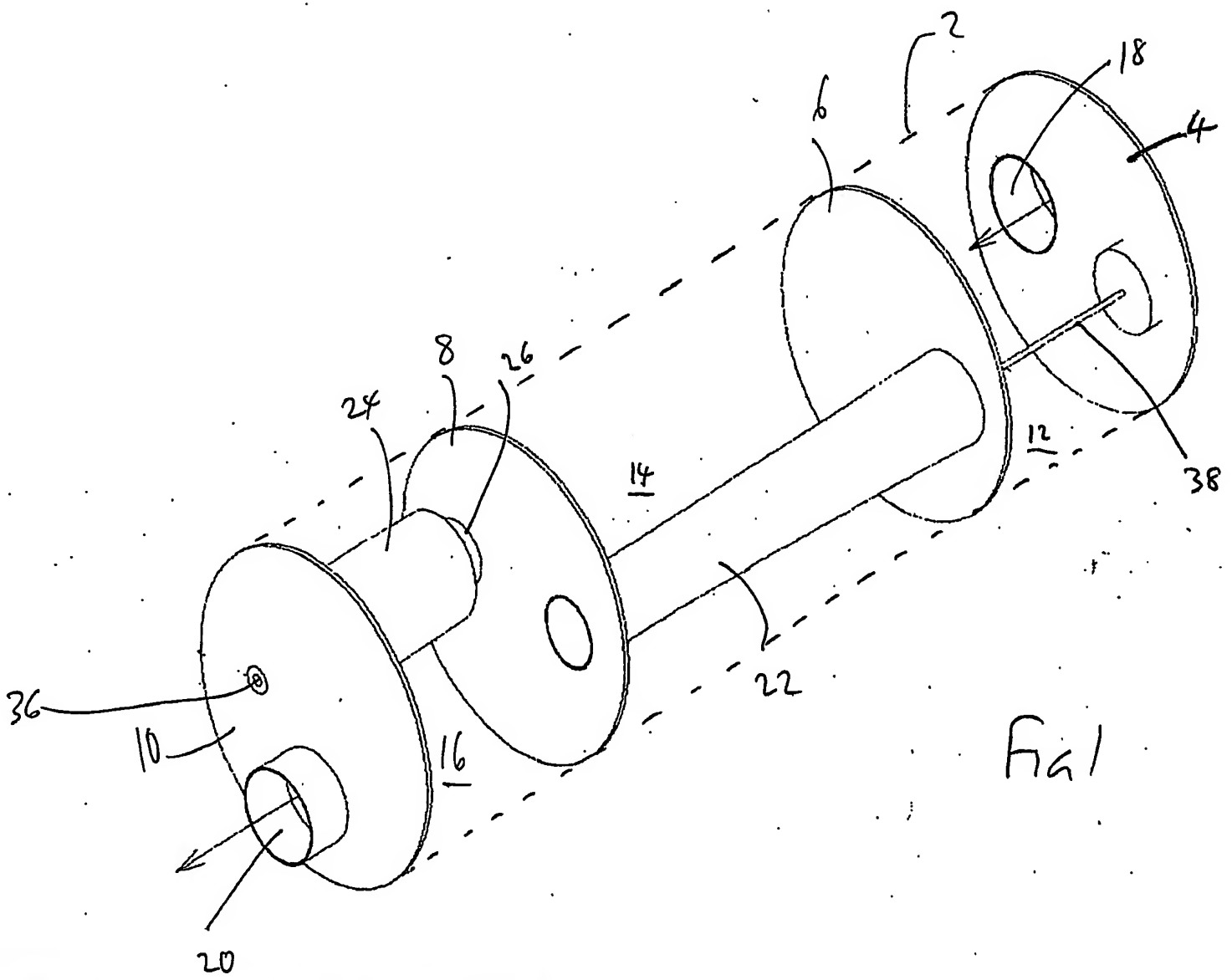


Fig 1

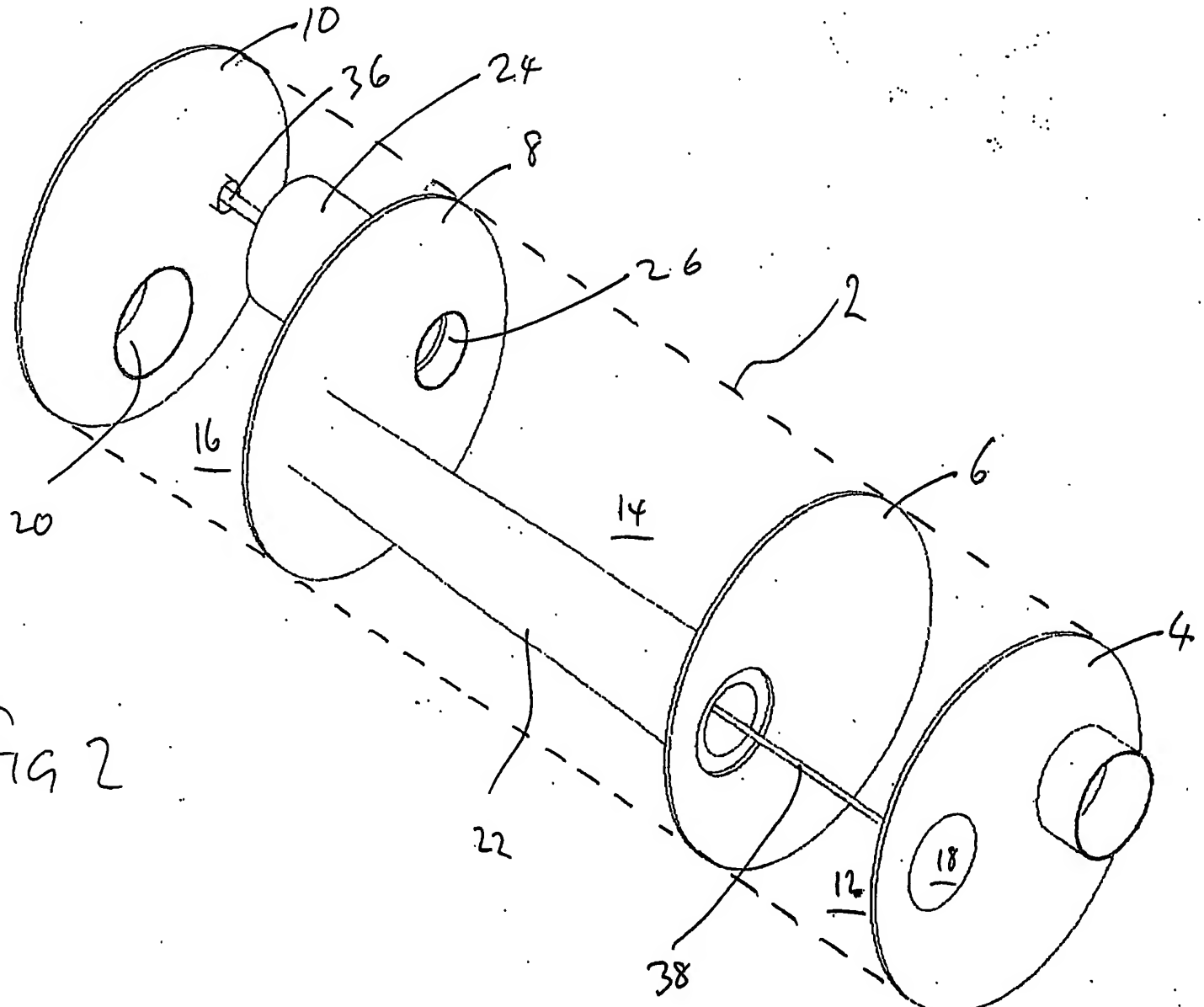


Fig 2

Fig 3

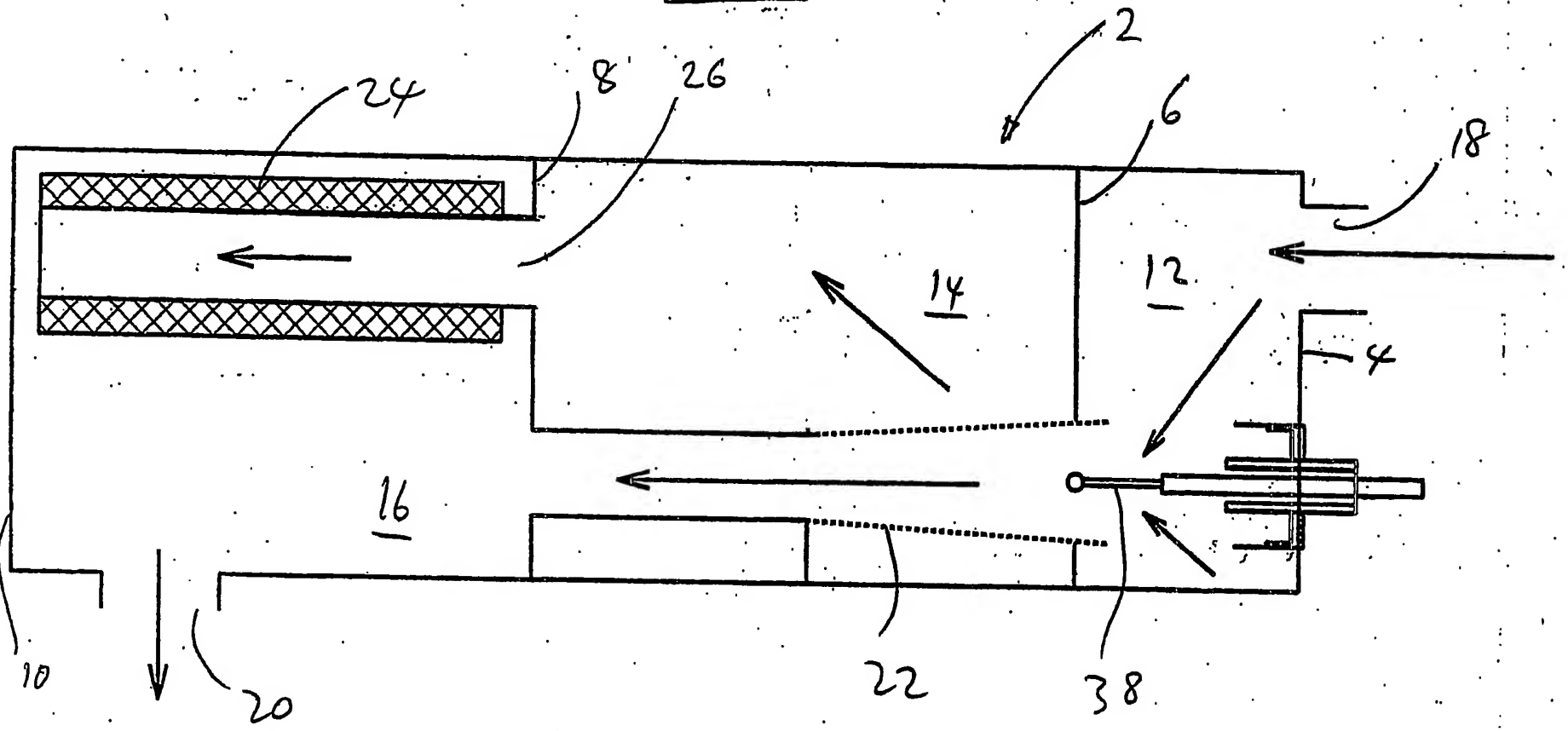


Fig 4

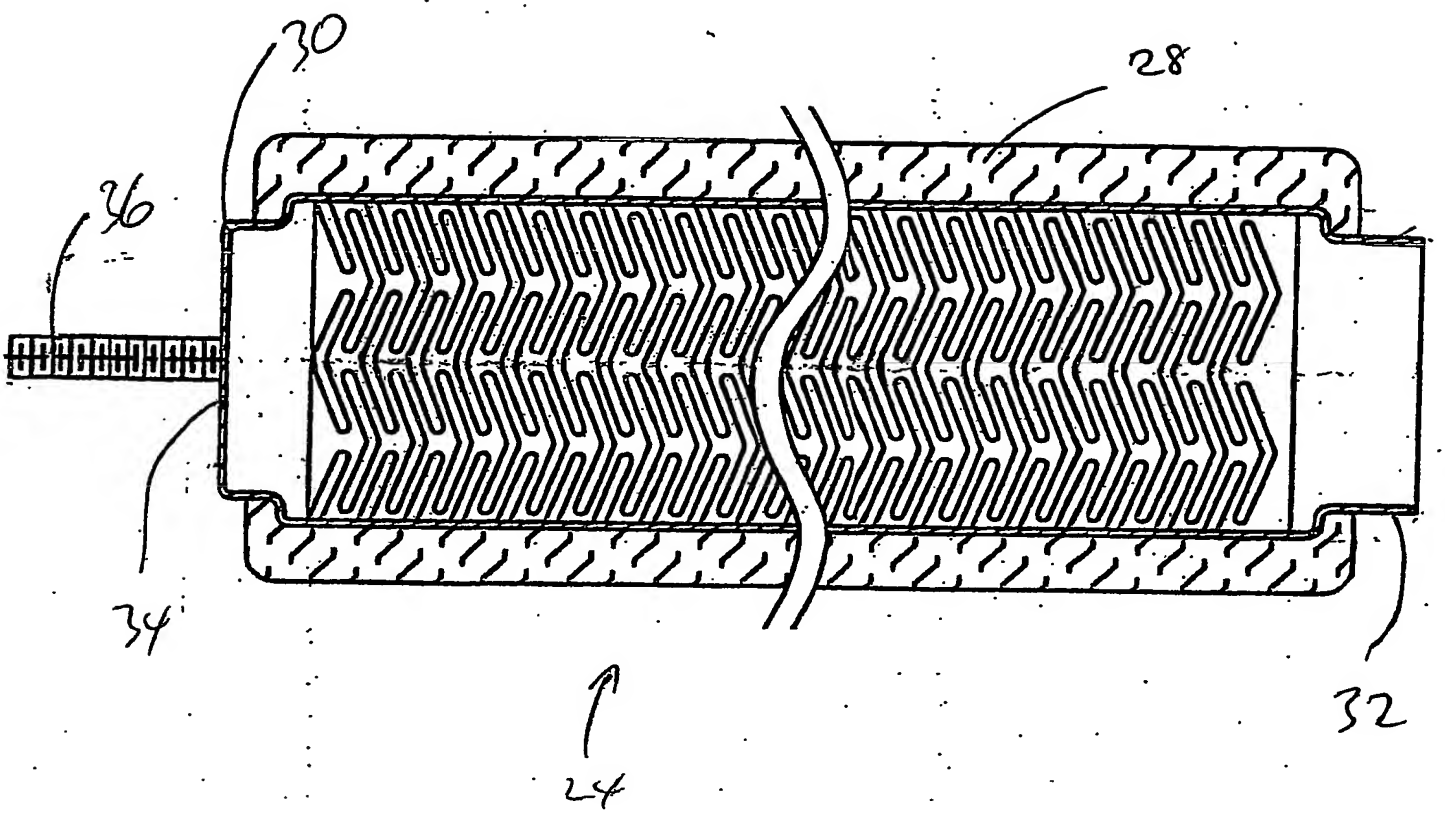


FIGURE 5

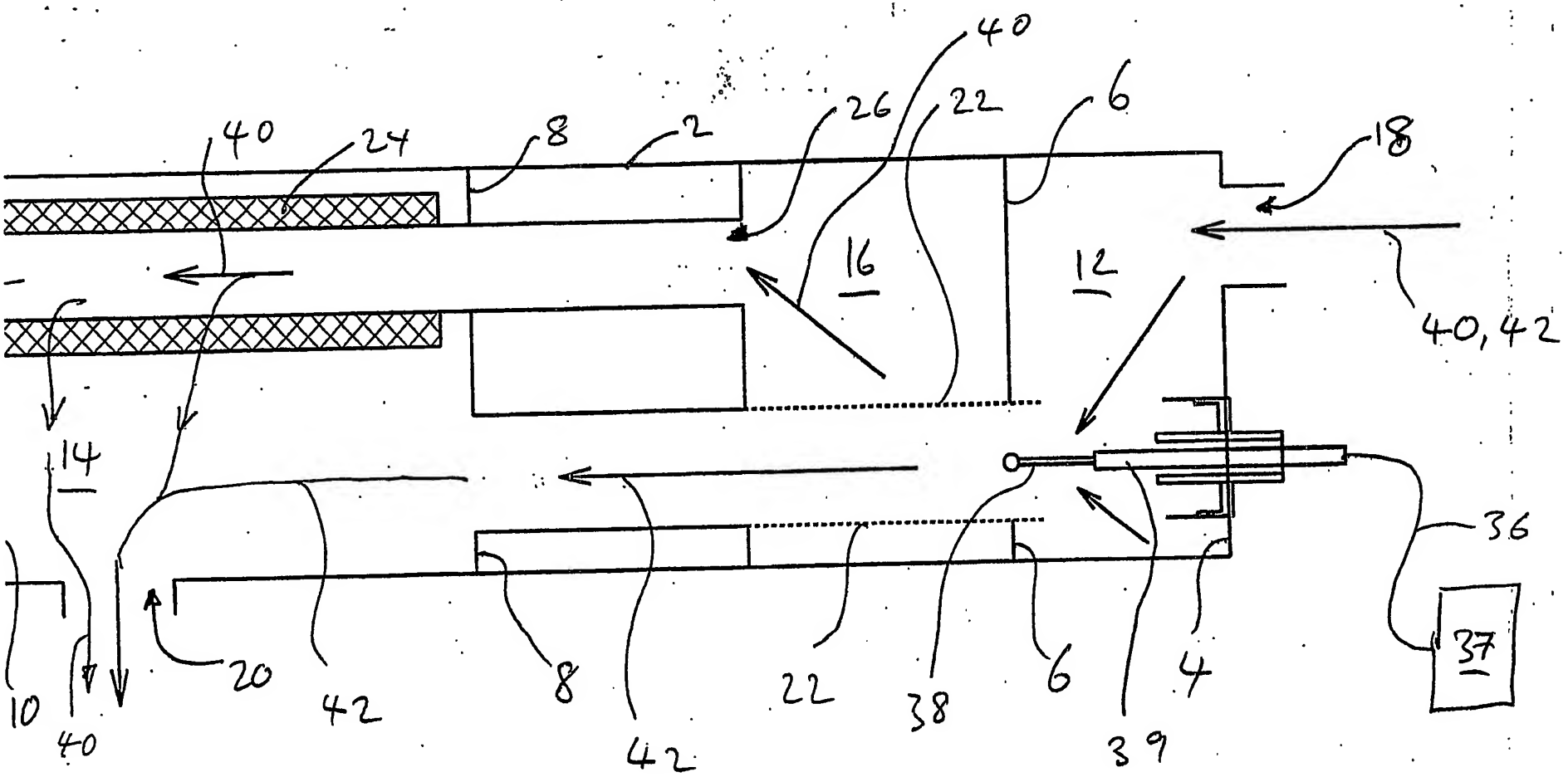


Figure 6

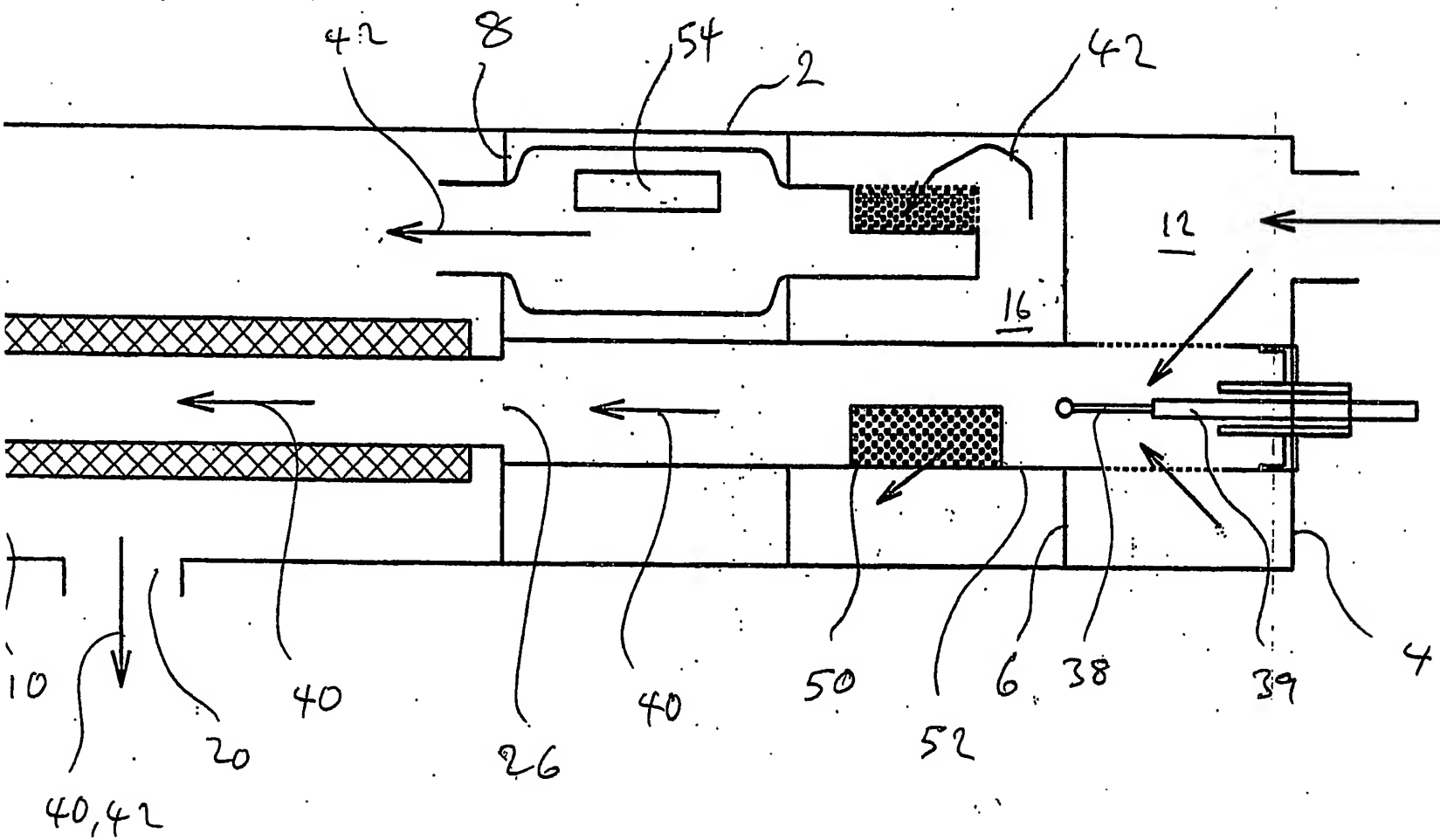


FIGURE 7

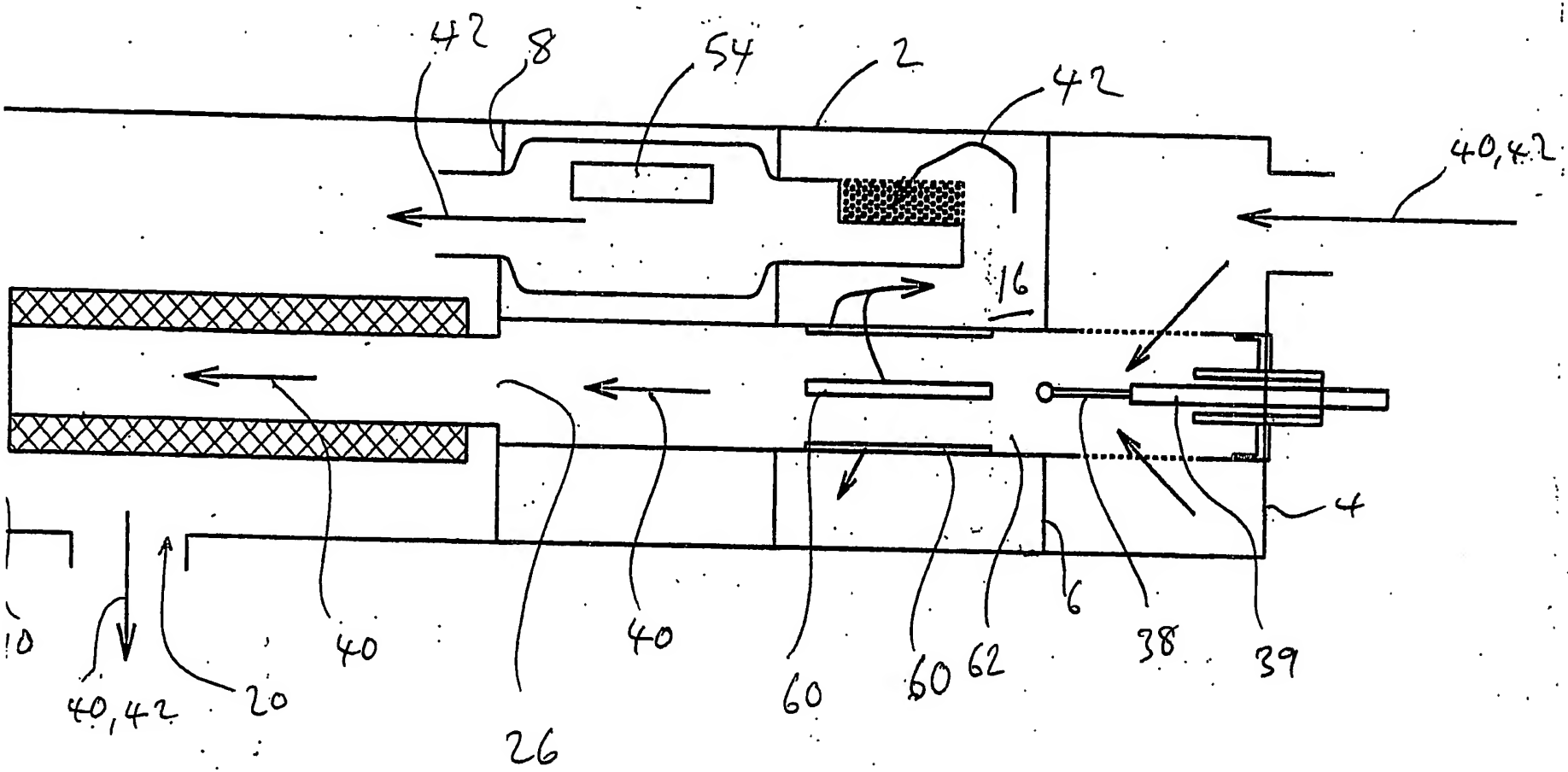


Fig 8

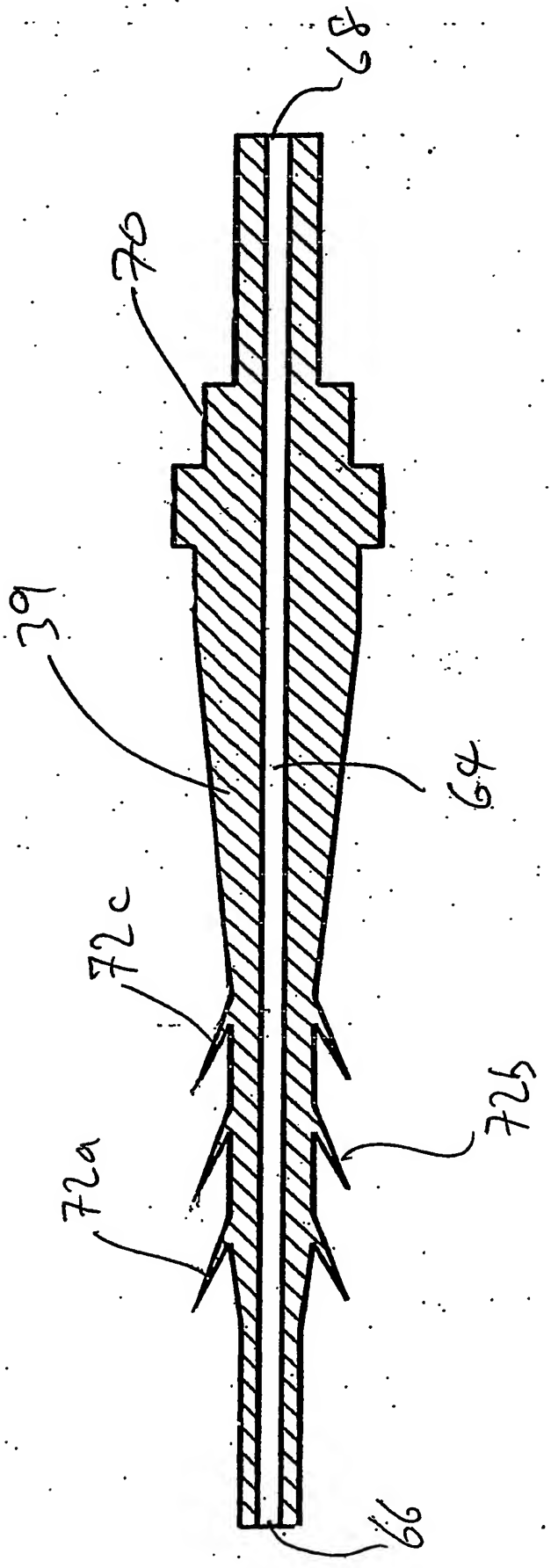
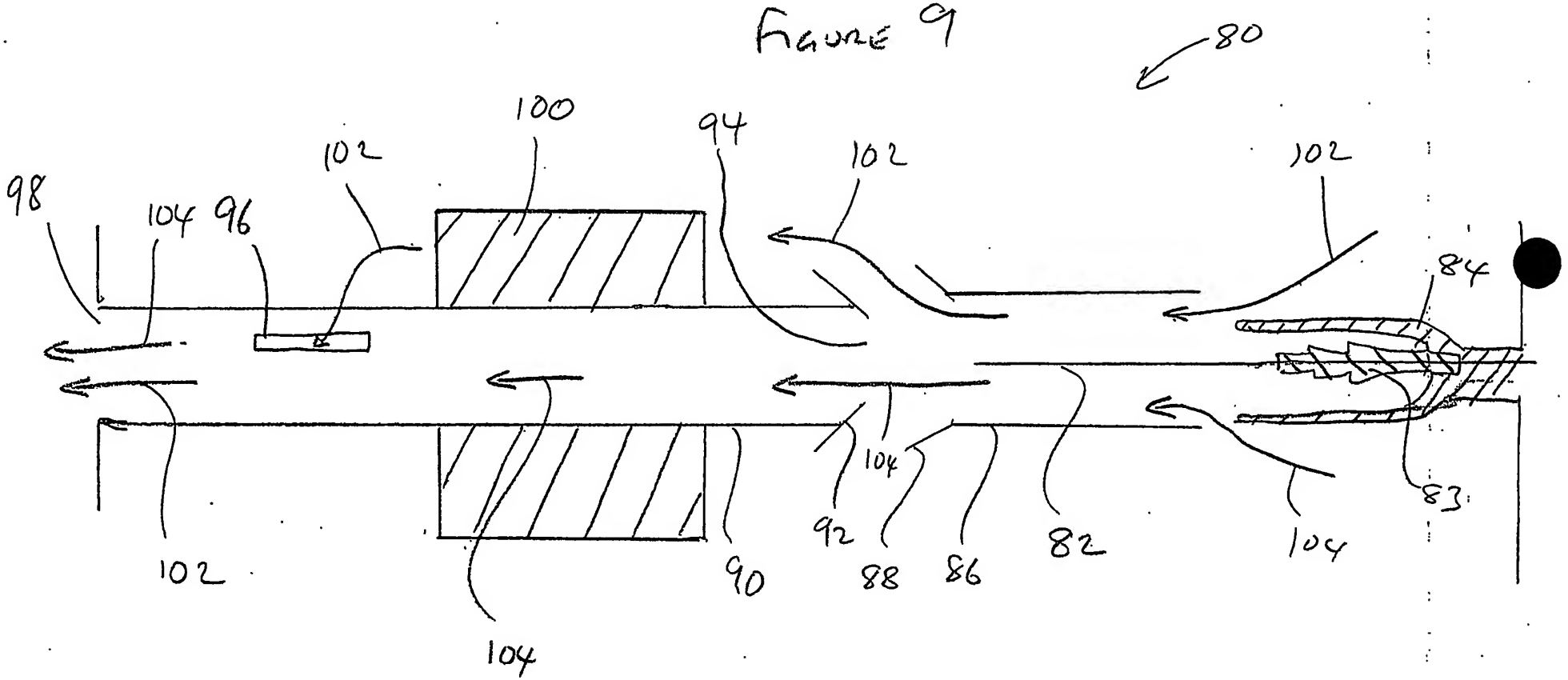


FIGURE 9



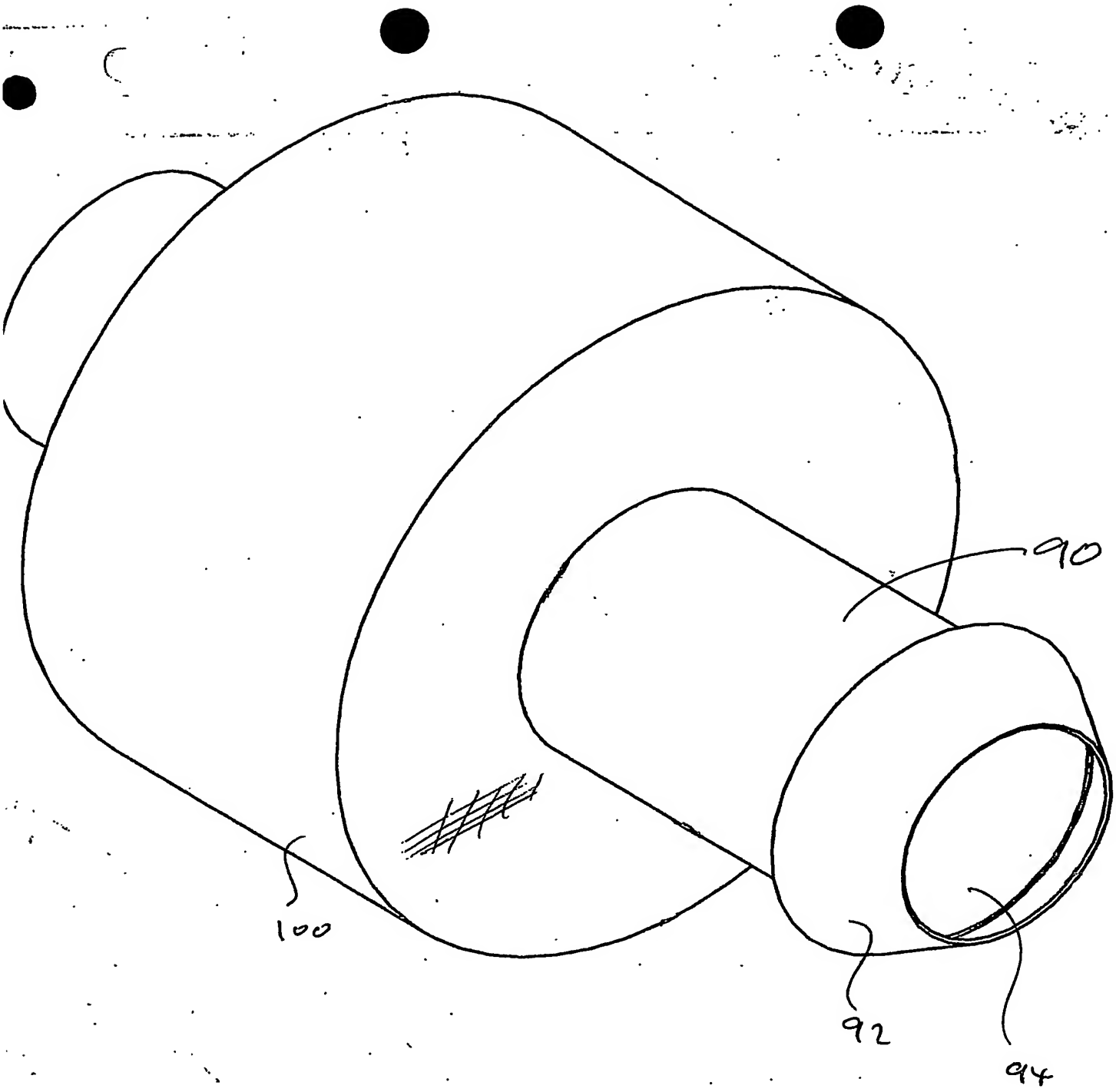


FIGURE 10

FIGURE 11